SCH 3U1: Final Exam Review

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You need to bring a **calculator** to the exam with you! (Know how to do pH on the calculator that you bring in!)

How to study:

- Review all of your old corrected tests
- Complete and **check** the review sheets
- Use your class time wisely and ask questions
- Help is always available, just ask ☺

You will be provided with a formula sheet.

Exam Review Questions:

1. Define the following: matter, chemistry, chemical property, physical property, chemical change, physical change

2. Explain how the elements of the periodic table are arranged. Explain in terms of atomic number, families or groups and periods. Describe the name and locations of the different types (or groups) of elements on a periodic table.

3. What does the group number tell about an atom? What does a period number tell about an atom?

4. Compare the subatomic particles based on charge, mass, and location.

5. Complete the following chart for each element:

Element	Number of p+, e-, and n°	Family name	Valence electrons	Valence (charge)	Lewis Dot diagram
Potassium	P=19, E=19, N=20	Alkali	1	K^+	K·
Carbon	P=6, E=6, N=6	Non-Metal	4	C^{+4} or C^{-4}	·C·
Nitrogen	P=7, E=7, N=7	Non-Metal	5	N^{-3}	·N:
Calcium	P=20, E=20, N=20	Alkaline Earth	2	Ca^{+2}	Ca·
Bromine	P=35, E=35, N=45	Halogen	7	Br^-	:Br:

6. What is an isotope? Give an example.

8. What is the periodic law?

9. Explain the following periodic table trends

Definition	Across a Period	Down a Group
Atomic radius		
Ionization energy		
Electron affinity		

10. What is the difference between a cation and an anion? Give an example of each.

12. a) What is electronegativity? How is it used to determine bond type?
b) What is the trend of electronegativity across a periodic table?

13. Compare an ionic compound(has ionic bonds) and a molecular compound(has covalent bonds). Compare the types of atoms/groups of atoms involved, electronegativity differences, strength of bond, and electron behaviour. Compare also the properties of ionic and covalent bonding.

14. For each of the following, draw the Lewis dot diagrams and state the name, formula and type of bonding:

Compound	Lewis Dot diagram	Name	Electronegativity difference	Type of bonding (ionic, polar covalent, pure covalent)
Na_2O				
CCl_4				
Cl_2				

15. Complete the chart below for the compounds

Name of Compound	Chemical Formula	Lewis Dot diagram	Electronegativity Difference	Type of Bond
	NH_3			
Water				
	CO_2			
	N_2			
	SO_3			
	NO_2			
	$MgOH$			

16. Write the names of the following:

a) SO_3
b) $Mg(NO_3)_2$
c) S_2Cl_2
d) O_2
e) $Li(OH)$
f) $PbCl_2$
g) CuO
h) CBr_4
i) H_2O
j) $Pb(SO_2)_2$

17. Write the chemical formulas of the following:

a) nitrogen gas
b) lithium carbonate
c) aluminum carbide
d) magnesium oxide
e) dinitrogen pentoxide
f) barium nitrate
g) sulfur trioxide
h) lead (IV) sulfide
i) carbon tetrachloride
j) aluminum phosphate

18. What are diatomic gases? List the 7 diatomic gases.

19. What are the five signs that a chemical reaction has occurred?

20. a) Name the 5 types of chemical reactions.

b) What is the law of conservation of mass?

21. For the following, complete the reaction, balance the equation, and classify the reaction.

a) $N_2 + H_2 \rightarrow$

b) $KCl + Mg(OH)_2 \rightarrow$

c) $Fe_2O_3 \rightarrow$

d) $Mg + FeCl_3 \rightarrow$

e) $Mg + O_2 \rightarrow$

f) $MgCl_2 + K_2(SO_4) \rightarrow$

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~~23. What is happening in a chemical reaction according to the collision theory?~~

24. Define molar mass. Why is molar mass used?

26. What is the molar mass of:
a) beryllium
b) sodium chloride
c) calcium sulfite
d) phosphorus trichloride
e) iron (III) nitrate

27. Find the mass of the following:
a) 3 moles of copper (II) chloride
b) 8.7 moles of silver nitrate
c) 0.43 moles of sulfur dichloride
d) 2.6 moles of calcium hydroxide

28. Find the number of moles of the following:
a) 100 g of aluminum
b) 3.4 g of barium iodide
c) 34.9 g of calcium nitrate
d) 256.2 g of lead (II) sulfate

29. Define the following terms: theoretical yield, limiting reagent, excess reactant, % yield, actual yield

30. For the reaction:

$N_2 + H_2 \rightarrow NH_3$

a) Balance the reaction
b) If 3.5mol of N_2 is added to a flask determine the amount of H_2 required to react?
c) How many **moles** of NH_3 will be produced?

31. For the reaction

$Ca(OH)_2 + HCl \rightarrow CaCl_2 + H_2O$

a) Balance the reaction.
b) How many **moles** of $CaCl_2$ is produced when 3.5g of $Ca(OH)_2$ are reacted?
c) How many **grams** of water will be produced when 7.5g of HCl are reacted?
d) How many **moles** of $Ca(OH)_2$ is required to make 3.5 mol of $CaCl_2$

32. For the reaction:

$$Fe_2O_3 + HCl \rightarrow FeCl_3 + H_2O$$

a) Balance the reaction
b) What mass of hydrogen chloride is required to react with 1.00×10^2 g of Fe_2O_3?
c) What **mass** of $FeCl_3$ will be produced?
d) How many moles of H_2O will be produced?

33. For the following reaction:

$Li_3N + 3H_2NH \rightarrow O_3 + 3LiOH$ $\quad Li_3N = 4.87$ g and $H_2O = 5.80$g

a) Determine which reactant is the **limiting reactant.**
b) Use the limiting reactant to determine the **mass** of LiOH produced.
c) How much excess reactant will be remaining after the reaction has occurred?

34. Barium sulfate forms as a precipitate in the following reaction:

$$Ba(NO_3)_2 + Na_2(SO_4) \rightarrow Ba(SO_4)_5 + 2Na(NO_3)$$

When 35.0g of $Ba(NO_3)_2$ is reacted with **excess** $Na_2(SO_4)$, 29.8g of the precipitate is recovered by the chemist.
a) What is the **theoretical yield** of the precipitate?
b) what is the **actual yield** of the precipitate?
c) What is the % yield?

35. An inorganic salt is composted of 17.6% sodium, 39.7% chromium and 42.8 % oxygen. What is the empirical formula?

36. $C_7H_8 + 2KMnO_4 \rightarrow KC_7H_5O_2 + 2MnO_2 + KOH + H_2O$
a) if 8.6g of C_7H_8 is reacted with excess $KMnO_4$. What is the **theoretical yield** of $KC_7H_5O_2$?
b) if the percentage yield is 70.0% what **mass** of $KC_7H_5O_2$ can be expected?
c) What mass of C_7H_8 is needed to produce 13.4g of $KC_7H_5O_2$ assuming a yield of 60%

$$\frac{13.4g}{60} = \frac{x}{100}$$

37. Define the following terms: soluble, concentration, indicator, solvent, pH, collision theory, solute, acid, saturated solution, base, unsaturated solution

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~~38. What are intermolecular forces? Name the three types of intermolecular forces.~~

39. a) What are ways to increase solubility of a solute in a liquid? (Name 3 ways and explain the difference between solids, liquids, and gases for one way)
b) What does "like dissolves like" mean? Give a specific example for each possibility.

40. Determine the **concentration** of the following solutions.
a) 3.5 mol of NaCl in 30.0 mL of water
b) 7.2g of NaCl in 50.0mL of water
c) 0.005g of $BaCl_2$ in 35.2mL of water.

41. Calculate the **volume** of water needed to make the following solutions.
a) $BeCl_2$ mass = 3.5g C= 0.05mol/L
b) $FeCl_3$ mass = 0.004g C= 5.2mol/L
c) NaCl moles = 2.5 C = 0.5mol/L

42. Determine the **mass** of solute needed to make the following solutions.
a) 1.00 L of 0.045 mol/L of $Ca(OH)_2$
b) 500mL of 0.100mol/L of $Ag(NO_3)$
c) 2.5L of 1.00mol/L of K_2CrO_4

43. What **volume** of 0.25mol/L solution can be made using 14g of NaOH?

44. Suppose you are given a solution of 1.25mol/L sodium chloride NaCl. What **volume** must you dilute to prepare the following solutions
a) 50 mL of 1.00mol/L NaCl
b) 200 mL of 0.800mol/L of NaCl
c) If you use 350 mL of the original solution and add 525 mL of water, what will be the concentration of your new solution?

45. Give an example of an acid and a base. What are 5 properties of an acid and of a base?

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~~46. Why was the pH Scale developed?~~

47. Calculate the pH for the following solutions.
a) $[H^+] = 0.027$ mol/L
b) 3.5g of HCl in 25mL of water
c) $[HF] = 5.3x10^{-7}$
d) 0.005 mol of H_2SO_4 in 300mL of water

48. Determine the $[H^+]$ for the following pH's
a) lemon juice pH = 2.2
b) stomach acid pH = 2.5
c) ammonia pH= 11.9

49. When an acid and base react the products are_____ and _____. This type of reaction is called _____ because the pH of the solution is _____.

50. What volume of 0.250 mol/L hydrochloric acid is needed to react completely with 37.2mL of 0.650mol/L potassium hydroxide?

51. 13.84mL of hydrochloric acid just neutralized 25.00mL of a 0.100mol/L solution of NaOH. What is the concentration of hydrochloric acid?

52. What is titration? Describe the steps you would complete to determine the concentration of HCl by using 0.5mol/L solution of NaOH.

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~~53.~~ What is the difference between hard and soft water and what does a water softener do – explain the precipitate chemistry.

54. Write the equations for the following laws ~~and write a brief summary of what the law represents:~~
1. Dalton
2. Gay-Lussac
3. Boyles'
4. Charles'
5. Combined Gas Law
6. Ideal Gas Law

55. What does each symbol represent, and what units do we use for each?
a) T
b) V
c) P
d) R
e) n

56. How do we convert from Celsius to Kelvin? What is STP?,lm,

57. A gas at 107 kPa and 300 K is cooled to 146 K at the same volume. What is the new pressure?

58. A 45.0 mL sample of nitrogen gas is collected at 1.4 atm. The nitrogen is compressed at a pressure of 9.6 atm. What is the final volume of the gas, if the temperature remains constant?

59. A gas collected at a temperature of 23 C, and pressure of 130 kPa, had a volume of 1.5 Litres under these lab conditions. What is the number of moles of gas that were collected during this lab.

60. The gas in car air bags is produced by the decomposition reaction of sodium azide, NaN_3. What volume of nitrogen gas will be produced if 123 g of sodium azide reacts at 25°C and 101.3 kPa?

61. At STP, 25L of hydrogen gas is reacted with 3.5 g of oxygen gas. How many litres of water vapour are produced?

62. IF YOU CAN DO THIS, YOU ARE A STOICHIOCHAMP!!!!!!

15 g of magnesium metal is dropped into 4.5L of 6.2 mol/L hydrochloric acid. How many litres of hydrogen gas are produced in the resulting reaction if it takes place at 20°C and 102kPa?

Be sure to go over reviews, quizzes and tests that you have – those are the BEST review for the exam! Don't just look at them – try the questions, then check that you got the questions right!!

Use your class time well and ask any questions – your teacher will be more than happy to answer any questions.

Chemistry Final Exam Review:

1. matter: anything with mass and volume (takes up space)

chemistry: the science of the composition, structure, properties, and reactions of matter

chemical property: a property observed when a substance chemically reacts with another substance
ex. react, decompose, tarnish, corrode, burn, explode

physical property: property observed without a chemical change involved
ex. colour, odour, solubility, physical state, conductivity, density

chemical change: substances are altered chemically (new substance produced) and display different physical and chemical properties after
ex. digesting food, battery looses its charge

physical change: substances may change in appearance but are not altered chemically (no change in composition), but are merely changed to another phase, separated, or combined
ex. change of state, boiling water, separating oxygen gas from air

2. The elements on the periodic table are arranged in order of increasing atomic number. Elements with the same amount of shells are arranged in periods (rows) and elements with similar properties are arranged in groups/families (columns).

Metals:
- located on the left side of the table
- good conductors, high luster, ductile (can stretch), malleable (form it), want to loose electrons

Non-metals:
- located on the right side of the table
- poor conductors, most are gases (only a few solids and only 1 liquid), want to gain electrons, dull, brittle

Metalloids:
- located along the staircase
- properties similar to metals and non-metals, semi conductors, solids

Transition Elements:
- solid
- less reactive than G1 or G2

G1 - Alkali Metals:
- reactive (highly), soft & solid, silver, shiny

G2: Alkaline Metals: shiny, silver, solid, fairly soft (not as soft as G1), fairly reactive (not as reactive as G1)

G17: Halogens:
- mainly gases (some liquids & solids)
- different colours, highly reactive non-metals

G18: Noble gases:
- very unreactive (full shells)
- lighter than air
- some form compounds

3. The group number tells how many outer electrons an atom has, and the period number tells how many shells an atom has.

4. Subatomic Particles:

The three subatomic particles are protons, neutrons, and electrons.

protons: • positive charge
• relative mass: 1.007 amu (can round to 1)

electrons: • negative charge
• relative mass: 0.0005 amu (round to 0)

neutrons: • no charge
• relative mass: 1.009 amu (can round to 1)

Location: In general, metals loose electrons to form cations, and non-metals tend to gain electrons to form anions

5. On Sheet.

6. An isotope is an atom of the same element but with a different mass. Basically, each isotope of an element has a different number of neutrons, which changes the mass. An example could be ^{6}Li. The mass number on the periodic table is the average of the mass of the isotopes of the element, which is why they are rarely whole numbers.

7. The periodic law states that when the elements are arranged in order of increasing atomic number, their properties show a periodic recurrence and gradual change. The periodic law is basically about the tendencies of element characteristics to increase or decrease as you go along a row or column of the periodic table.

9.

Definition	Across a Period	Down a Group
Atomic Radius → the radius / size of an atom	• as you go across a period there is more nuclear charge which pulls the outer electrons closer, therefore making the atomic radius smaller	• as you go down a group, each atom has another energy level PLUS more shielding so the atoms atomic radius gets bigger
Ionization Energy → energy required to remove an electron from the ground state of a gaseous atom or ion	• as you go across a period, the nuclear charge increases, therefore the outer electrons are held tighter, meaning that more energy is required to remove the first electron (ionization energy increases)	• as you go down a group, ionization energy decreases because although the nuclear charge is the same, the valence electrons are further from the nucleus, therefore more shielding, and less energy required to remove the first electron.

Electron Affinity → energy released when an electron is added to a gaseous atom	• electron affinity increases (becomes more exothermic) as you go from left to right across a period	• electron affinity decreases and becomes less exothermic as you go down a group

10. A cation is a positive ion (electron has been lost) and an anion is a negative ion (electron has been gained.
    ex. cation: K^+
    anion: Cl^-

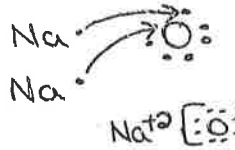
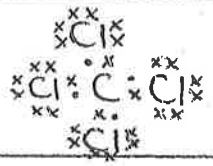
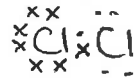
12. a) Electronegativity is the ability of an atom of an element to attract electrons when the atom is in a compound (bonded). You can use electronegativity to determine bond types by finding the difference in electronegativity of a compound If the difference in electronegativity is between 1.7 - 4.0 the bonds are ionic, if it is between 0.4 - 1.7 the bonds are polar covalent, and if it is between 0.0 - 0.4 the bonds are non-polar covalent.

    b) Electronegativity tends to increase from left to right across a period.

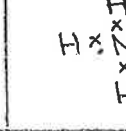
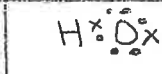
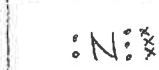
13. An Ionic compound is when a complete transfer of 1 or more electrons from one atom to another forming oppositely charged ions that attract eachother where a molecular compound is when valence electrons are shared between

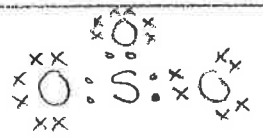
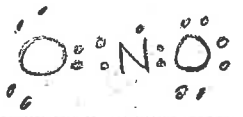
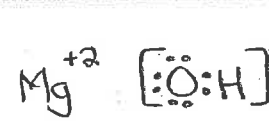
atoms. Ionic compounds tend to occurr between a metal and a non-metal, and have an electronegativity difference of 1.7 - 4.0, where as a molecular compound tends to occurr between 2 non-metals and has an electronegativity difference of 0.0 - 1.7. Ionic bonds are stronger than covalent bonds. Ionic compounds are generally crystalline solids at room temperature, and molecular compounds are generally gases and liquids at room temperature. The melting and boiling points of molecular compounds are lower than those of ionic compounds.

14.

Compound	Lewis dot diagram	name	electronegativity difference	Type of bonding
Na_2O		sodium oxide	2.51	ionic
CCl_4		carbon tetrachloride	0.61	polar covalent
Cl_2		chlorine gas	0.0	non-polar covalent

15.

Name of compound	Chemical formula	Lewis dot diagram	Electronegativity difference	Type of bond
nitrogen trihydride	NH_3		0.84	polar covalent
water	H_2O		1.24	polar covalent
Carbon dioxide	CO_2		0.89	polar covalent
Nitrogen Gas	N_2		0.0	non-polar covalent

sulfer trioxide	SO_3		0.86	polar covalent
nitrogen dioxide	NO_2		0.4	non-polar covalent
magnesium hydroxide	$MgOH$		N/A	ionic : covalent

16. a) sulfer trioxide
b) magnesium nitrate
c) disulfer dichloride
d) oxygen gas
e) lithium hydroxide
f) lead (II) chloride
g) copper (II) oxide
h) carbon tetra bromide
i) water
j) lead (II) hyposulfite

17. a) N_2 b) $Li_2(CO_3)$ c) Al_4C_3 d) MgO e) N_2O_5
f) $Ba(NO_3)_2$ g) SO_3 h) PbS_2 i) CCl_4 j) $AlPO_4$

18. Diatomic gases are gases made of 2 atoms of the same element. The 7 diatomic gases are: 1) H, 2) O, 3) F, 4) Br, 5) I, 6) N, 7) Cl

19. 1) gas / bubbles form
2) a precipitate forms or a colour change
3) a change in temperature, smell, taste, and/or texture
4) light or sound emitted
5) new substance formed.

20. a)
1) synthesis
2) decomposition
3) single displacement
4) double displacement
5) combustion

b) The law of concervation of mass states that the total mass of reactants equals the total mass of products.

21. a) $N_2 + 3H_2 \rightarrow 2NH_3$ synthesis

b) $2KCl + Mg(OH)_2 \rightarrow 2KOH + MgCl_2$ double displacement

c) $2Fe_2O_3 \rightarrow 4Fe + 3O_2$ decomposition

d) $3Mg + 2FeCl_3 \rightarrow 3MgCl_2 + 2Fe$ single displacement

e) $Mg + O_2 \rightarrow MgO_2$ synthesis

f) $MgCl_2 + K_2(SO_4) \rightarrow MgSO_4 + 2KCl$ double displacement

23. OMIT

24. Molar mass is the mass of 1 mol of a substance, and the units for molar mass are g/mol. Molar mass is used to calculate the moles (n) and/or the mass (m).

26. a) beryllium : $M = 9.012\ g/mol$
b) Sodium Chloride ($NaCl$): $M = 58.44\ g/mol$
c) calcium sulfite ($CaSO_3$): $M = 120.14\ g/mol$
d) phosphorus trichloride (PCl_3): $M = 137.32\ g/mol$
e) iron (III) nitrate: ($Fe(NO_3)_3$) : $M = 241.88\ g/mol$

27. a) Copper (II) chloride ($CuCl_2$)

$n = 3.0\ mol$

$M = 134.45\ g/mol$

$m = n \times M$

$= 3.0 mol \times 134.45\ g/mol$

$m = 403.35\ g$

b) Silver nitrate ($AgNO_3$)

$n = 8.7\ mol$

$M = 169.91\ g/mol$

$m = n \times M$

$= 8.7 mol \times 169.91\ g/mol$

$m = 1478.22\ g$

c) Sulfer dichloride (SCl_2)

$n = 0.43\ mol$

$M = 102.96\ g/mol$

$m = n \times M$

$= 0.43 mol \times 102.96\ g/mol$

$m = 44.27\ g$

d) Calcium hydroxide ($Ca(OH)_2$)

$n = 2.6\ mol$

$M = 74.096\ g/mol$

$m = n \times M$

$= 2.6 mol \times 74.096\ g/mol$

$m = 192.65\ g$

28. a) aluminum (Al)

$m = 100\,g$

$M = 26.98\ g/mol$

$n = \frac{m}{M}$

$= \frac{100\,g}{26.98\ g/mol}$

$n = 3.7\ mol$

b) barium iodide (BaI_2)

$m = 3.4\,g$

$M = 391.1\ g/mol$

$n = \frac{m}{M}$

$= \frac{3.4\,g}{391.1\ g/mol}$

$n = 0.0087\ mol$

c) Calcium nitrate ($Ca(NO_3)_2$)

$m = 34.9\,g$

$M = 164.1\ g/mol$

$n = \frac{m}{M}$

$= \frac{34.9\,g}{164.1\ g/mol}$

$n = 0.213\ mol$

d) lead (II) sulfate ($PbSO_4$)

$m = 256.2\,g$

$M = 303.26\ g/mol$

$n = \frac{m}{M}$

$= \frac{256.2\,g}{303.26\ g/mol}$

$n = 0.845\ mol$

29. limiting reactant: reactant that is completely consumed in a chemical reaction, and determines how much product is produced

excess reactant: reactant that is still present after reaction is complete

theoretical yield: amount or mass of product predicted based on the stoichiometry of the chemical equation

% yield: the ratio, expressed as a %, of the actual yield to the theoretical yield

actual yield: amount or mass of product actually collected during an experiment or industrial process

30. $N_2 + H_2 \rightarrow NH_3$

a)
$N_2 + 3H_2 \rightarrow 2NH_3$

b)
$N_2 + 3H_2 \rightarrow 2NH_3$

$n = 3.5\,mol$ → $n = 10.5\,mol$

$\div 1 \times 3$

c)
$N_2 + 3H_2 \rightarrow 2NH_3$

$n = 3.5\,mol$ → $n = 7.0\,mol$

$\div 1 \times 2$

31. a) $Ca(OH)_2 + 2HCl \rightarrow CaCl_2 + 2H_2O$

b)
$Ca(OH)_2 + 2HCl \rightarrow CaCl_2 + 2H_2O$

$n = 0.047\,mol$

$m = 3.5\,g$

$M = 74.096\,g/mol$

$n = \frac{m}{M}$

$= \frac{3.5\,g}{74.096\,g/mol}$

$n = 0.047236\,mol$

$\div 1 \times 1$

c)
$Ca(OH)_2 + 2HCl \rightarrow CaCl_2 + 2H_2O$

$m = 7.5\,g$

$M = 36.458\,g/mol$

$n = \frac{m}{M}$

$= \frac{7.5\,g}{36.458\,g/mol}$

$n = 0.205716\,mol$

$n = 0.205716167\,mol$

$M = 18.016\,g/mol$

$m = n \times M$

$= 0.2057\,mol \times 18.016\,g/mol$

$m = 3.7\,g$

$\div 2 \times 2$

d)

$Ca(OH)_2 + 2HCl \rightarrow CaCl_2 + 2H_2O$

$n = 3.5\,mol$ $\qquad$ $n = 3.5\,mol$

$\div 1 \times 1$

32. a)

$Fe_2O_3 + 6HCl \rightarrow 2FeCl_3 + 3H_2O$

b)

$Fe_2O_3 + 6HCl \rightarrow 2FeCl_3 + 3H_2O$

$m = 1.00 \times 10^2\,g$ $\qquad$ $n = 3.757\,mol$

$m = 100\,g$ $\qquad$ $M = 36.458\,g/mol$

$M = 159.7\,g/mol$ $\qquad$ $m = n \times M$

$n = \frac{m}{M}$ $\qquad$ $= 3.757\,mol \times 36.458\,g/mol$

$= \frac{100\,g}{159.7\,g/mol}$ $\qquad$ $m = 136.97\,g$

$n = 0.626174\,mol$

$\div 1 \times 6$

c)

$Fe_2O_3 + 6HCl \rightarrow 2FeCl_3 + 3H_2O$

$m = 1.00 \times 10^2\,g$ $\qquad$ $n = 1.252348\,mol$

$= 100\,g$ $\qquad$ $M = 162.2\,g/mol$

$M = 159.7\,g/mol$ $\qquad$ $m = n \times M$

$n = \frac{m}{M}$ $\qquad$ $= 1.252348\,mol \times 162.2\,g/mol$

$= \frac{100\,g}{159.7\,g/mol}$ $\qquad$ $m = 203.13\,g$

$= 0.626174\,mol$

$\div 1 \times 2$

d)

$Fe_2O_3 + 6HCl \rightarrow 2FeCl_3 + 3H_2O$

$m = 1.00 \times 10^2\,g$ $\qquad$ $n = 1.8785\,mol$

$= 100\,g$

$M = 159.7\,g/mol$

$n = \frac{m}{M}$

$= \frac{100\,g}{159.7\,g/mol}$

$n = 0.626174\,mol$

$\div 1 \times 3$

33. a) $Li_3N + 3H_2O \rightarrow 3LiOH + NH_3$

$m = 4.87g$ $m = 5.80g$

$M = 34.833 g/mol$ $M = 18.016 g/mol$

$n = \frac{m}{M}$ $n = \frac{m}{M}$

$= \frac{4.87g}{34.833 g/mol}$ $= \frac{5.80g}{18.016 g/mol}$

$n = \frac{0.1398 mol}{1}$ $n = \frac{0.321936 mol}{3}$

$= 0.1398 mol$ $= 0.107312 mol$ → limiting reactant

b) $Li_3N + 3H_2O \longrightarrow 3LiOH + NH_3$

$n = 0.321936 mol$ $n = 0.321936 mol$

$M = 23.949 g/mol$

$m = n \times M$

$= 0.321936 mol \times 23.949 g/mol$

$m = 7.71g$

$\div 3 \times 3$

c) $Li_3N + 3H_2O \longrightarrow 3LiOH + NH_3$

$n = 0.107312 mol$ $n = 0.321936 mol$

$M = 34.833 g/mol$

$\div 3 \times 1$

$0.13980995 - 0.107312019$

$= 0.032497931 mol$

$m = n \times M$

$= 0.032497931 mol \times 34.833 g/mol$

$m = 1.13g$

∴ excess reactant left over is 1.13g

34. a)

$Ba(NO_3)_2 + Na_2(SO_4) \rightarrow Ba(SO_4) + 2\,Na(NO_3)$

$m = 35.0\,g$

$M = 261.32\,g/mol$

$n = \frac{m}{M} = \frac{35.0\,g}{261.32\,g/mol}$

$n = 0.1339\,mol$

$\div 1 \times 1$

$n = 0.1339\,g$ (for $Ba(SO_4)$)

$M = 233.36\,g/mol$

$m = n \times M$

$= 0.1339\,g \times 233.36\,g/mol$

$m = 31.26\,g$

∴ Theoretical yield = 31.26 g

b) Actual yield: 29.8 g

c) $\%\ yield = \frac{AY}{TY} \times 100\%$

$= \frac{29.8\,g}{31.26\,g} \times 100\%$

%yield = 95.3%

35.

element	% mass	molar mass	moles	simplest ratio	simplist whole # ratio
Na	17.6 g	22.99 g/mol	0.76555 mol	$\frac{0.76555}{0.76346} = 1$	2
Cr	39.7 g	52.00 g/mol	0.76346 mol	$\frac{0.76346}{0.76346} = 1$	2
O	42.8 g	16 g/mol	2.675 mol	$\frac{2.675}{0.76346} = 3.5$	7

∴ empirical formula is: $Na_2Cr_2O_7$

36. a)

$C_7H_8 + 2\,KMnO_4 \rightarrow KC_7H_5O_2 + 2\,MnO_2 + KOH + H_2O$

$m = 8.6\,g$

$M = 92.134\,g/mol$

$n = \frac{m}{M} = \frac{8.6\,g}{92.134\,g/mol}$

$n = 0.093342306\,mol$

$\div 1 \times 1$

$n = 0.093342306\,mol$

$M = 160.21\,g/mol$

$m = n \times M$

$= 0.093342306\,mol \times 160.21\,g/mol$

$m = 14.95\,g$ → Theoretical yield

b)

$$\%\ \text{yield} = \frac{AY}{TY} \times 100\%$$

$$70\% = \frac{AY}{14.95\,g} \times 100\%$$

$$AY = \frac{70\%\,(14.95)\,g}{100\%}$$

$AY = 10.465\,g$ → ∴ 10.465 g can be expected

c)

$C_7H_8 + 2KMnO_4 \rightarrow KC_7H_5O_2 + 2MnO_2 + KOH + H_2O$

$n = 0.13940037\,mol$

$M = 92.134\,g/mol$

$m = n \times M$

$= 0.13940037\,mol \times 92.134\,g/mol$

$m = 12.84\,g$

$\frac{13.4g}{60} = \frac{m}{100}$

$\frac{13.4g(100)}{60} = \frac{m(60)}{60}$

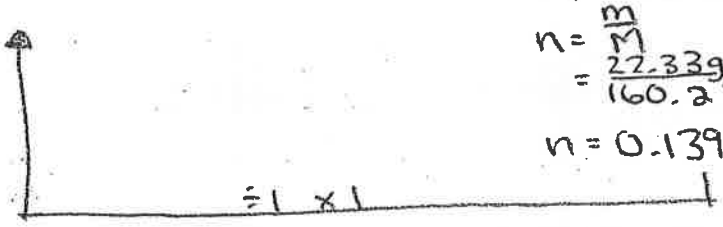
$m = 22.33g$

$M = 160.21\,g/mol$

$n = \frac{m}{M}$

$= \frac{22.33g}{160.21\,g/mol}$

$n = 0.13940037\,mol$



37. Soluble: something that can dissolve in water

Concentration: the ratio of the quantity of solute to the quantity of solution or solvent; usually quantity of solute per unit volume of solution

Indicator: a substance that indicates the degree of acidity or basicity of a solution through characteristic colour change.

Solvent: the part of a solution that dissolves the solute (usually the greater amount, often water)

pH: pH means "power of hydrogen", and it is the measure of hydrogen ion concentration. pH measures the acidity or alkalinity of a substance. pH can range from 0 (strongest acid) to 14 (strongest base)

Collision theory: states that effective collisions between reactant molecules must occur in order for the reaction to occur.

Solute: The part of a solution that is being dissolved (usually the lesser amount)

Acid: an acid is a substance that dissociates to form H^+ ions in solution according to the Arrhenius theory, and according to the Bronstead-Lowry theory, an acid is a substance that provides a proton to another substance

Saturated Solution: contains the maximum quantity of solute that dissolves at that temperature.

Base: a base is any substance that dissociates to form OH^- ions in solution according to the Arrhenius theory, and according to the Bronstead-Lowry theory a base is any substance that recieves a proton from an acid.

Unsaturated Solution: contains less than the maximum amount of solute that can dissolve at a particular temperature

38. OMIT

39. a) Ways to increase the solubility of a solute in a liquid could be:

1) molecule size
2) temperature
3) polarity

Although these three factors could increase the solubility of a solute in a liquid, they may not do the same thing if it was a solid or gas. For example, temperature only slightly increases the solubility of a solute in a liquid, however temperature highly increases the solubility of a solute in a solid, and decreases the solubility of a solute in a gas. Therefore, temperature affects the solubility of a solute in gases, liquids, and solids in different ways.

b) "Like dissolve like" is referring to the polarity of a compound (whether it is polar or non-polar). For example, a polar compound such as sodium chloride would dissolve in a polar solvent like water, or a non-polar compound such as iodine would dissolve in a non-polar solvent like benzene.

40. a) NaCl:

$n = 3.5\ mol$

$V = 30.0\ ml = 0.030\ L$

$C = \frac{n}{V} = \frac{3.5\ mol}{0.030\ L}$

$C = 116.67\ mol/L$

b) NaCl:

$m = 7.2\ g$

$M = 58.44\ g/mol$

$n = \frac{m}{M} = \frac{7.2\ g}{58.44\ g/mol}$

$n = 0.123203285\ mol$

$V = 50.0\ mL = 0.050\ L$

$C = \frac{n}{V} = \frac{0.1232\ mol}{0.050\ L}$

$C = 2.464\ mol/L$

c)
$BaCl_2$:

$m = 0.005\,g$
$M = 208.2\,g/mol$
$n = \frac{m}{M}$
$= \frac{0.005\,g}{208.2\,g/mol}$
$n = 0.00002401S\,mol$

$V = 35.2\,mL$
$= 0.0352\,L$

$C = \frac{n}{V}$
$= \frac{0.00002401S\,mol}{0.0352\,L}$
$\boxed{C = 0.00068\,mol/L}$

41. a)
$BeCl_2$:

$m = 3.5g$
$M = 79.912\,g/mol$
$n = \frac{m}{M}$
$= \frac{3.5g}{79.912\,g/mol}$
$n = 0.043798178\,mol$

$C = 0.05\,mol/L$

$V = \frac{n}{C}$
$= \frac{0.043798178\,mol}{0.05\,mol/L}$
$\boxed{V = 0.876L}$

b)
$FeCl_3$:

$m = 0.004g$
$M = 162.2\,g/mol$
$n = \frac{m}{M}$
$= \frac{0.004g}{162.2\,g/mol}$
$n = 0.00002466l\,mol$

$C = 5.2\,mol/L$

$V = \frac{n}{C}$
$= \frac{0.00002466l\,mol}{5.2\,mol/L}$
$\boxed{V = 0.000004742\,L}$

c)
$NaCl$:

$n = 2.5\,mol$
$C = 0.5\,mol/L$

$V = \frac{n}{C}$
$= \frac{2.5\,mol}{0.5\,mol/L}$
$\boxed{V = 5L}$

42. a)
$Ca(OH)_2$:

$V = 1.00L$
$C = 0.045\,mol/L$
$n = C \times V$
$= 0.045\,mol/L \times 1.00L$
$n = 0.045\,mol$

$M = 74.096\,g/mol$

$m = n \times M$
$= 0.045mol \times 74.096g/mol$
$\boxed{m = 3.33g}$

b)

$Ag(NO_3)$:

$V = 500 ml$

$= 0.500 L$

$C = 0.100 mol/L$

$n = c \times V$

$= 0.100 mol/L \times 0.500 L$

$n = 0.05 mol$

$M = 169.91 g/mol$

$m = n \times M$

$= 0.05 mol \times 169.91 g/mol$

$\boxed{m = 8.496 g}$

c)

K_2CrO_4:

$V = 2.5 L$

$C = 1.00 mol/L$

$n = c \times V$

$= 1.00 mol/L \times 2.5 L$

$n = 2.5 mol$

$M = 194.2 g/mol$

$m = n \times M$

$= 2.5 mol \times 194.2 g/mol$

$\boxed{m = 485.5 g}$

43. NaOH:

$C = 0.25 mol/L$

$m = 14 g$

$M = 39.998 g/mol$

$n = \frac{m}{M}$

$= \frac{14 g}{39.998 g/mol}$

$n = 0.35 mol$

$V = \frac{n}{C}$

$= \frac{0.35 mol}{0.25 mol/L}$

$\boxed{V = 1.4 L}$

44. a)

$V_1 = ?$

$C_1 = 1.25 mol/L$

$V_2 = 50 ml$

$C_2 = 1.00 mol/L$

$C_1V_1 = C_2V_2$

$\frac{1.25(V_1)}{1.25} = \frac{1.00(50)}{1.25}$

$\boxed{V = 40 mL}$

b)

$V_1 = ?$

$C_1 = 1.25 mol/L$

$V_2 = 200 ml$

$C_2 = 0.800 mol/L$

$C_1V_1 = C_2V_2$

$\frac{1.25(V_1)}{1.25} = \frac{0.800(200)}{1.25}$

$\boxed{V = 128 mL}$

* c) $V_1 = 350\,mL$
$C_1 = 1.25\ mol/L$
$V_2 = 525\,mL$
$C_2 = ?$

$V_1C_1 = V_2C_2$

$\frac{350(1.25)}{525} = \frac{525(C_2)}{525}$

$C = 0.83\ mol/L$

45.

Properties	Acids	Bases
Taste	sour	bitter
Feel	like water	slippery
Conductivity in solution	conducts electricity	conducts electricity
Reaction with litmus paper	turns blue paper red	turns red paper blue
Reaction with metals	produces hydrogen gas	no reaction
Example	citric acid	sodium hydroxide

46. OMIT

47. a) $[H^+] = 0.027\ mol/L$

$pH = -\log[H^+]$
$= -\log[0.027]$
$pH = 1.7$

b) HCl:
$m = 3.5g$
$M = 36.458\ g/mol$
$n = \frac{m}{M}$
$= \frac{3.5g}{36.458\ g/mol}$
$n = 0.096\ mol$

$V = 25\,ml$
$= 0.025L$

$C = \frac{n}{V}$
$= \frac{0.096\ mol}{0.025L}$
$C = 3.84\ mol/L$

$pH = -\log[H^+]$
$= -\log(3.84)$
$pH = -0.5$

c) $[HF] = 5.3 \times 10^{-7}$

d)

H_2SO_4:

$n = 0.005\,mol$

$V = 300\,ml$

$= 0.300\,L$

$C = \frac{n}{V}$

$= \frac{0.005\,mol}{0.300\,L}$

$C = 0.0167\,mol/L$

$pH = -\log[H^+]$

$= -\log[0.0167]$

$pH = 1.8$

a)

48. lemon juice:

$pH = 2.2$

$[H^+] = 10^{-pH}$

$= 10^{-2.2}$

$[H^+] = 0.0063\,mol/L$

b)

Stomach acid:

$pH = 2.5$

$[H^+] = 10^{-pH}$

$= 10^{-2.5}$

$[H^+] = 0.00316\,mol/L$

c)

Ammonia:

$pH = 11.9$

$[H^+] = 10^{-pH}$

$= 10^{-11.9}$

$[H^+] = 1.2589 \times 10^{-12}\,mol/L$

49. When an acid and a base react the products are salt and water. This type of reaction is called a neutralization because the pH of the solution is 7 (neutral).

50. $HCl + KOH \longrightarrow H_2O + KCl$

$n = 0.02418\ mol$ $V = 37.2\ ml$

$C = 0.250\ mol/L$ $= 0.0372\ L$

$V = \frac{n}{C}$ $C = 0.650\ mol/L$

$= \frac{0.02418\ mol}{0.250\ mol/L}$ $n = C \times V$

$V = 0.0967\ L$ $= 0.650\ mol/L \times 0.0372\ L$

$n = 0.02418\ mol$

$= 1 \times 1$

51. $HCl + NaOH \rightarrow H_2O + NaCl$

$V = 13.84\ ml$ $V = 25\ ml$

$= 0.01384\ L$ $= 0.025\ L$

$n = 0.0025\ mol$ $C = 0.100\ mol/L$

$C = \frac{n}{V}$ $n = C \times V$

$= \frac{0.0025\ mol}{0.01384\ L}$ $= 0.100\ mol/L \times 0.025\ L$

$C = 0.181\ mol/L$ $n = 0.0025\ mol$

$= 1 \times 1$

52. A titration is a procedure used to determine the concentration of a solution using a standardized solution.

53. OMIT

54. 1) Dalton's: $P_{TOTAL} = P_1 + P_2 + P_3 + \ldots + P_n$

2) Gay-Lussac: $\frac{P_1}{T_1} = \frac{P_2}{T_2}$

3) Boyles': $P_1V_1 = P_2V_2$

4) Charles': $\frac{V_1}{T_1} = \frac{V_2}{T_2}$

5) Combined Gas Law: $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

6) Ideal Gas Law: $\frac{n_1}{V_1} = \frac{n_2}{V_2}$

55. a) T: temperature → units: K

b) V: volume → units: L

c) P: pressure → units: kPa

d) $R = 8.314 \frac{kPa \cdot L}{mol \cdot K}$ *This is always constant!*

e) n: moles → units: mol

56. To convert from celcius to kelvin, you add 273 to the temperature in °C. STP stands for Standard temperature and pressure. According to the combined gas law, if something is at STP, it is at 0°c and and 101.3 kPa. In the ideal gas law, the molar volume of gases at STP

is equal to 22.4 L/mol.

57. $P_1 = 107\ kPa$, $T_1 = 300K$, $T_2 = 146\ K$, $P_2 = ?$

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

$$\frac{107}{300} = \frac{P_2}{146}$$

$$P_2 = \frac{107(146)}{300}$$

$$\boxed{P_2 = 52\ kPa}$$

58. $P_1 = 1.4\ atm$, $V_1 = 45\ ml$, $P_2 = 9.6\ atm$, $V_2 = ?$

$$P_1V_1 = P_2V_2$$

$$\frac{1.4(45)}{9.6} = \frac{9.6(V_2)}{9.6}$$

$$\boxed{V_2 = 6.56\ mL}$$

59. $P = 130\ kPa$, $T = 23°C + 273 = 296K$, $V = 1.5L$, $R = 8.314$, $n = ?$

$$PV = nRT$$

$$\frac{130(1.5)}{(8.314)(296)} = \frac{n(8.314)(296)}{(8.314)(296)}$$

$$\boxed{n = 0.079\ mol}$$

60. $2NaN_3 \rightarrow 2Na + 3N_2$

$m = 123g$

$n = \frac{m}{M} = \frac{123g}{65.02\ g/mol}$

$n = 1.8917\ mol$

$\div 2 \times 3$

$T = 298K$

$P = 101.3\ kPa$

$R = 8.314$

$n = 2.837588\ mol$

$$PV = nRT$$

$$\frac{101.3(V)}{101.3} = \frac{2.837588(8.314)(298)}{101.3}$$

$$\boxed{V = 69.4L}$$

61. $2H_2$ + O_2 → $2H_2O$

H_2: V = 25 L, T = 273 K, P = 101.3 kPa, R = 8.314, PV = nRT

$101.3(25) = n(8.314)(273)$

$(8.314)(273) \quad (8.314)(273)$

$n = \frac{1.115775412}{2}$

$n = 0.55788706 \text{ mol}$

O_2: m = 3.5 g, M = 32 g/mol

$n = \frac{m}{M} = \frac{3.5 \text{ g}}{32 \text{ g/mol}}$

$n = 0.109375 \text{ mol}$

$\frac{0.109375 \text{ mol}}{1}$

$n = 0.109375 \text{ mol}$ *limiting*

H_2O: T = 273 K, P = 101.3 kPa, R = 8.314, $n = 0.21875 \text{ mol}$, PV = nRT

$\frac{101.3(V)}{101.3} = \frac{0.21875(8.314)(273)}{101.3}$

$V = 4.9 \text{ L}$

62. Mg + $2HCl$ → $MgCl_2$ + H_2

Mg: m = 15 g, M = 24.31 g/mol

$n = \frac{m}{M} = \frac{15 \text{ g}}{24.31 \text{ g/mol}}$

$n = 0.617030029 \text{ mol}$

$\frac{0.617030029 \text{ mol}}{1}$

$n = 0.617030029 \text{ mol}$ *limiting*

HCl: V = 4.5 L, C = 6.2 mol/L

$n = C \times V$

$= 6.2 \text{ mol/L} \times 4.5 \text{ L}$

$n = 27.9 \text{ mol}$

$\frac{27.9 \text{ mol}}{2}$

$n = 13.95 \text{ mol}$

$\times 1$

H_2: T = 273 + 20°C = 293, P = 102 kPa, $n = 0.617030029 \text{ mol}$, R = 8.314, PV = nRT

$\frac{102(V)}{102} = \frac{0.617(8.314)(293}{102}$

$V = 14.7 \text{ L}$